Open-Source Network Tester

- RIPE88
- May 20, 2024
- Online
- Vladimir Vassilev, Lightside Instruments AS
- draft-ietf-bmwg-network-tester-cfg

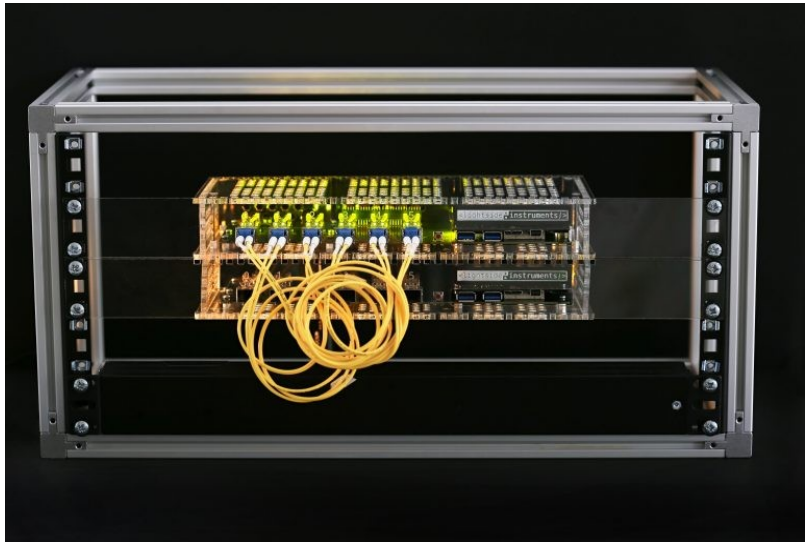
Quiz: Which 2 of the 5 network testers below have standard based management interfaces and protocols?

A

B

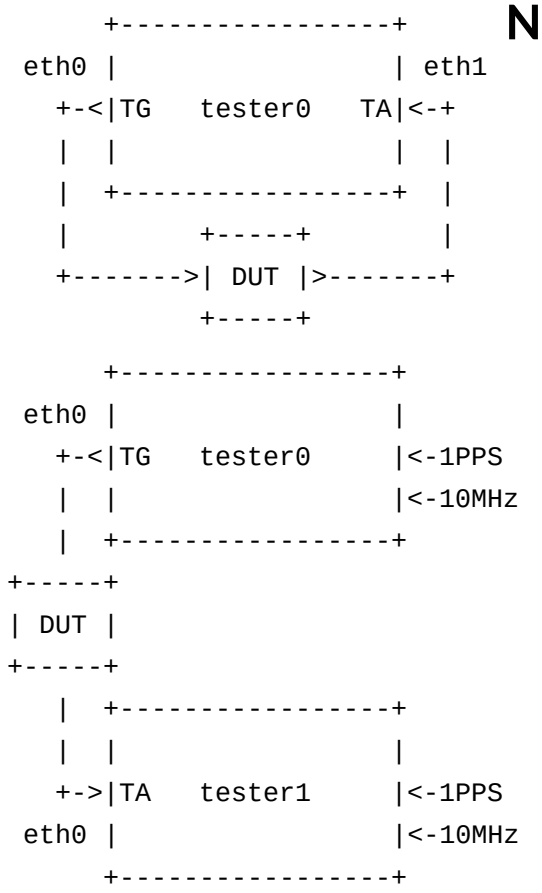
C

D



E

Network Tester Management Solutions



- Command line (SCPI) over TCP/IP or GPIB (IEEE 488)
- Cisco TRex (YAML,JSON-RPC)
- Keysight Open Traffic Generator APIs (REST) & Data Models (2023)
- High Level Test Application Programming Interface (HLTAPI)
- Other

- YANG (RFC7950) model and NETCONF(RFC6241) protocol implementation

Test & Measurement Instrument Automation Wish-list 1/2

1. have an interchangeable interface - IVI, YANG/NETCONF
2. be scalable instead of complex – combining L2-3 with >L4 devices is unnecessary
3. have transactional management model with hierarchical (tree-like) configuration and state representation - YANG/NETCONF
4. model that does not put constrains on the precision of the implementation (example: traffic spec with Pkt/sec, Bandwidth or interframe-gaps)
5. model that does not limit re-usability of implementations
have model with optional features and a mechanism to announce the set of implemented features – RFC8525 YANG Library)
6. management model has to have a compatible and simple command line manipulation syntax which does not require extra work to be developed – **yangcli**

Test & Measurement Instrument Automation Wish-list 2/2

7. model has to be as deterministic as it can be - avoid RFC 8342 NMDA delayed commit provision on test instruments
8. have model applicable to real devices, discrete event network simulation and gate level simulations
9. should generate report that is both human readable and machine readable – record the NETCONF session
10. bulk recording of state variables – NETCONF <get> with filter
11. be implemented based on open standards if such are available (ietf-network, ietf-interfaces)
12. processing requirements should be in the range of common embedded systems used for management of test instruments and configuration transaction should take less then 10 ms

Chronology 1/2

1965 HP develops „the interfacing of all future HP instruments“ and patents the Interface Bus (HP-IB) later known as GPIB
1975 IEEE488 Standard Digital Interface for Programmable Instrumentation is published

1980 RFC760 Internet Protocol is published

1999 RFC2544 Benchmarking Methodology for Network Interconnect Devices is published

2006 RFC4741 NETCONF Configuration Protocol is published

2010 RFC6020 YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF) is published

2014 Cisco acquires Tail-f (Sweden)

2015 TRex generator/analyzer released by Cisco

2016 First open-source YANG/NETCONF tool-chain is accepted into Debian (yuma123)

Chronology 2/2

2017 Keysight acquires Ixia

2018 Transpacket AS and ADVA demonstrate setup using YANG/NETCONF managed network traffic generators

2019 First draft version published to IETF BMWG

2020 Lightside Instruments AS publishes open-source hardware implementation of the draft (1Gb Ethernet)

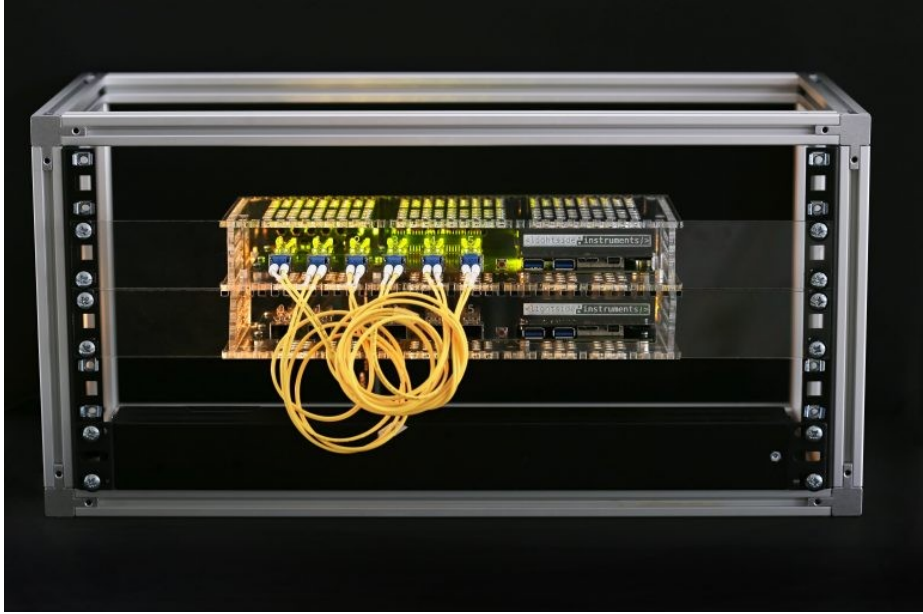
2021 Lightside Instruments AS publishes open-source implementation of RFC2544 benchmark

2022 IETF BMWG adopts A YANG Data Model for Network Tester Management draft

2023 Teledyne acquires Xena Networks

2024 Keysight outbids Viavi and acquires Spirent

The project



Specification:
* draft-ietf-bmwg-network-tester-cfg-04

Client side examples:
* rfc2544-benchmark.py (Python)

Device side:
* Software - YANG/NETCONF server instrumentation code (C)
* Firmware - (Verilog)
* Hardware – off-the-shelf FPGA module Ultra96 + 6x SFP+ network programmability kit shield (KiCAD, Walk-through, OSHWA UIDs NO000005, NO000006)
* Pre-silicon gate level simulation with cocotb/iverilog as alternative to target hardware

Open-source rfc2544-benchmark.py run - 1/5

* git repository -> rfc2544-benchmark 407 lines of python code

```
> rfc2544-benchmark.py --config=config.xml --dst-node=tester0 \
--dst-node-interface=eth1 \
--src-node=tester0 --src-node-interface=eth0 --dst-mac-address="70:B3:D5:EC:20:01" \
--src-mac-address="70:B3:D5:EC:20:00" -dst-ipv4-address="192.0.2.2" \
--src-ipv4-udp-port=49184 \
--src-ipv4-address="192.0.2.1" --frame-size=64 --trial-time=120 --speed=1000000000 \
| tee log.txt | grep "^#"
...
```

Open-source rfc2544-benchmark.py run - 2/5

```
#===Throughput===
#1 1488095.238095 pps,  20 octets interframe gap, 100.00% ... 2001294 / 2976190
#2  744047.619048 pps, 104 octets interframe gap,  50.00% ... 1488095 / 1488095
#3 1116071.428571 pps,  48 octets interframe gap,  75.00% ... 2001280 / 2232142
#4  925925.925926 pps,  71 octets interframe gap,  62.22% ... 1851851 / 1851851
#5 1016260.162602 pps,  59 octets interframe gap,  68.29% ... 2001280 / 2032520
#6  968992.248062 pps,  65 octets interframe gap,  65.12% ... 1937984 / 1937984
#7  992063.492063 pps,  62 octets interframe gap,  66.67% ... 1984126 / 1984126
#8  1000000.000000 pps, 61 octets interframe gap,  67.20% ... 2000000 / 2000000
#9  1008064.516129 pps, 60 octets interframe gap,  67.74% ... 2001289 / 2016129
#10 1000000.000000 pps, 61 octets interframe gap,  67.20% ... 2000000 / 2000000
#Result: 1000000.000000 pps
...
```

Open-source rfc2544-benchmark.py run - 3/5

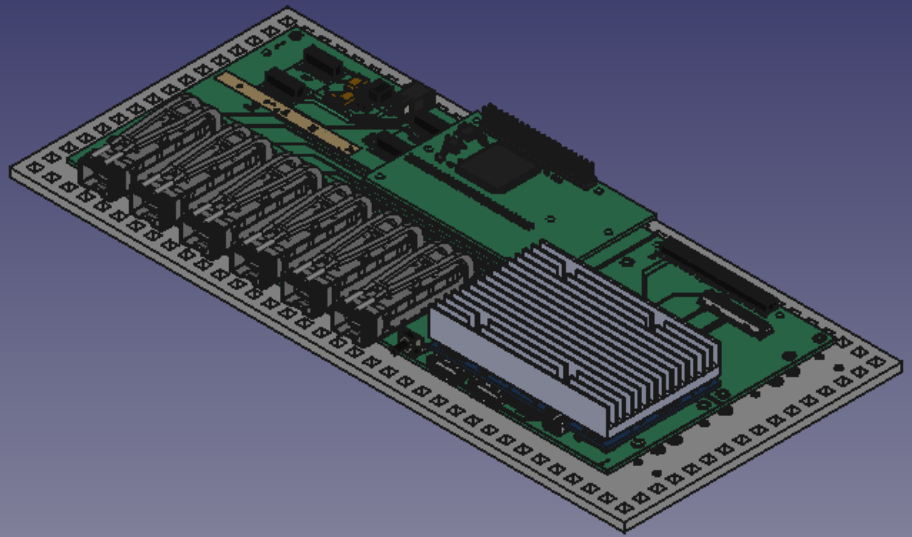
```
#===Latency===
#Measurement style - bit forwarding
#1 24624 ns (min=7024 ns, max=24624 ns) ... 2000000 / 2000000
#2 24472 ns (min=7016 ns, max=24472 ns) ... 2000000 / 2000000
#3 24624 ns (min=7024 ns, max=24624 ns) ... 2000000 / 2000000
#4 24360 ns (min=7016 ns, max=24360 ns) ... 2000000 / 2000000
...
#14 24360 ns (min=7024 ns, max=24360 ns) ... 2000000 / 2000000
#15 24224 ns (min=7016 ns, max=24224 ns) ... 2000000 / 2000000
#16 24208 ns (min=7016 ns, max=24208 ns) ... 2000000 / 2000000
#17 24704 ns (min=7016 ns, max=24704 ns) ... 2000000 / 2000000
#18 24752 ns (min=7016 ns, max=24752 ns) ... 2000000 / 2000000
#19 24760 ns (min=7016 ns, max=24760 ns) ... 2000000 / 2000000
#20 24176 ns (min=7016 ns, max=24176 ns) ... 2000000 / 2000000
#Result: 24440.400000 nanoseconds
...
```

Open-source rfc2544-benchmark.py run - 4/5

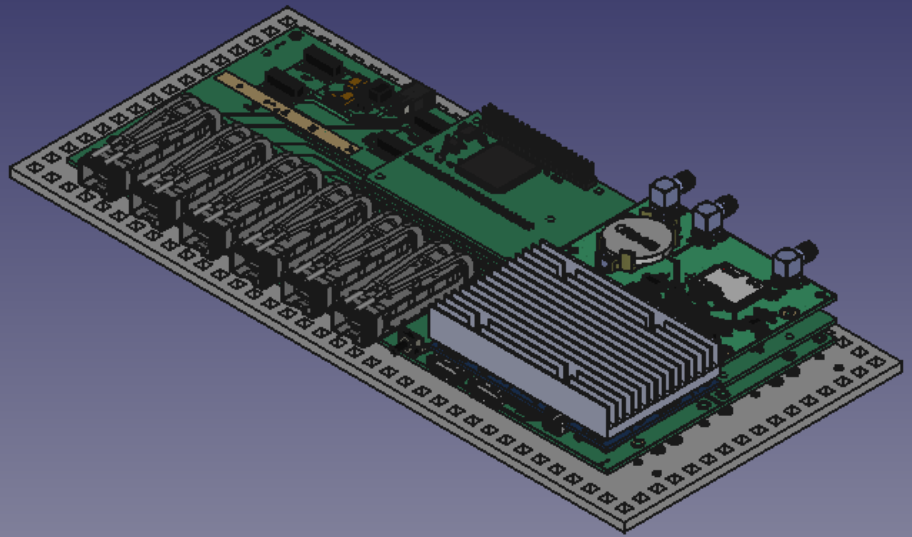
```
#===Frame loss rate===
#1 100% rate, 32% loss, (100.000000% rate actual), 1488095.238095 pps (1488095.238095 pps actual),
 20 octets interframe gap ...    2001302 / 2976190
#2 90% rate, 24% loss, (89.361702% rate actual),   1339285.714286 pps (1329787.234043 pps actual),
 30 octets interframe gap ...    2001276 / 2659574
#3 80% rate, 15% loss, (80.000000% rate actual),   1190476.190476 pps (1190476.190476 pps actual),
 41 octets interframe gap ...    2001279 / 2380952
#4 70% rate, 3% loss, (69.421488% rate actual),    1041666.666667 pps (1033057.851240 pps actual),
 57 octets interframe gap ...    2001302 / 2066115
#5 60% rate, 0% loss, (59.574468% rate actual),     892857.142857 pps ( 886524.822695 pps actual),
 77 octets interframe gap ...    1773049 / 1773049
#6 50% rate, 0% loss, (49.704142% rate actual),     744047.619048 pps ( 739644.970414 pps actual),
105 octets interframe gap ...    1479289 / 1479289
...
```

Open-source rfc2544-benchmark.py run - 5/5

```
#===Back to back frames===
#1 2 back-to-back frames ... 2 / 2
#2 4 back-to-back frames ... 4 / 4
...
#10 1024 back-to-back frames ... 1024 / 1024
#11 2048 back-to-back frames ... 1915 / 2048
#12 1536 back-to-back frames ... 1536 / 1536
#13 1792 back-to-back frames ... 1748 / 1792
#14 1664 back-to-back frames ... 1664 / 1664
#15 1728 back-to-back frames ... 1686 / 1728
#16 1696 back-to-back frames ... 1683 / 1696
#17 1680 back-to-back frames ... 1675 / 1680
#18 1672 back-to-back frames ... 1672 / 1672
#19 1676 back-to-back frames ... 1676 / 1676
#20 1678 back-to-back frames ... 1678 / 1678
#21 1679 back-to-back frames ... 1679 / 1679
#Result: >= 1679
```

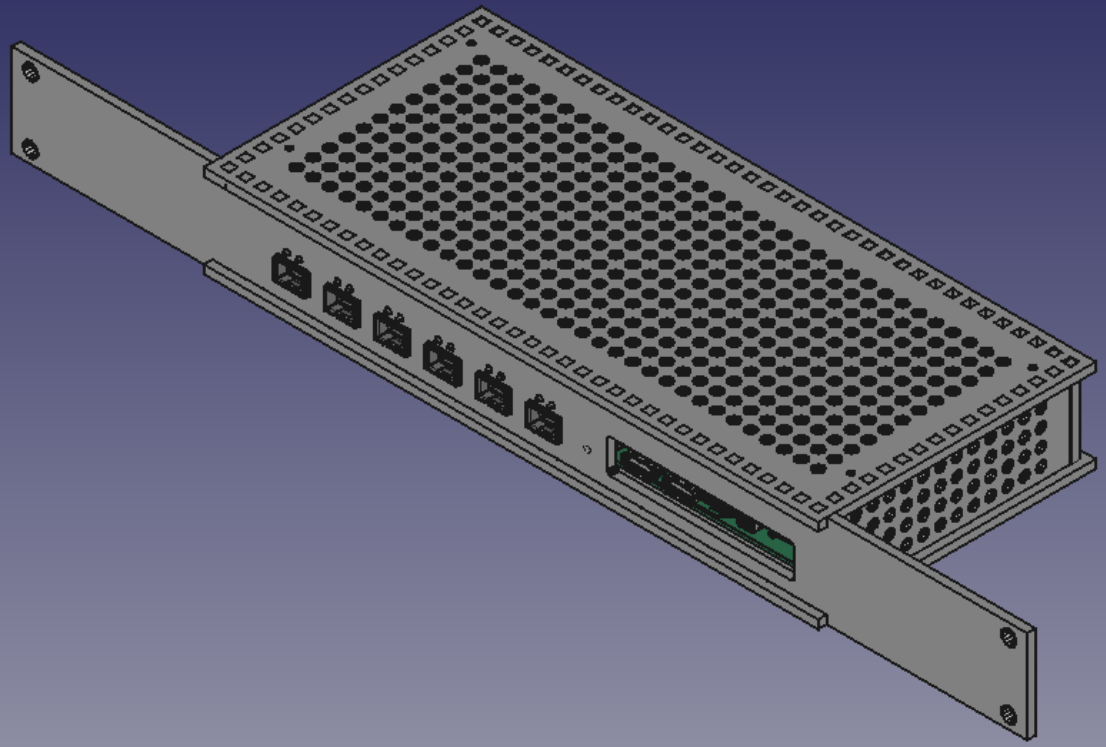


OSHW
NO000005



OSHW
NO000005

OSHW
NO000006



OSHW
NO000005

OSHW
NO000006

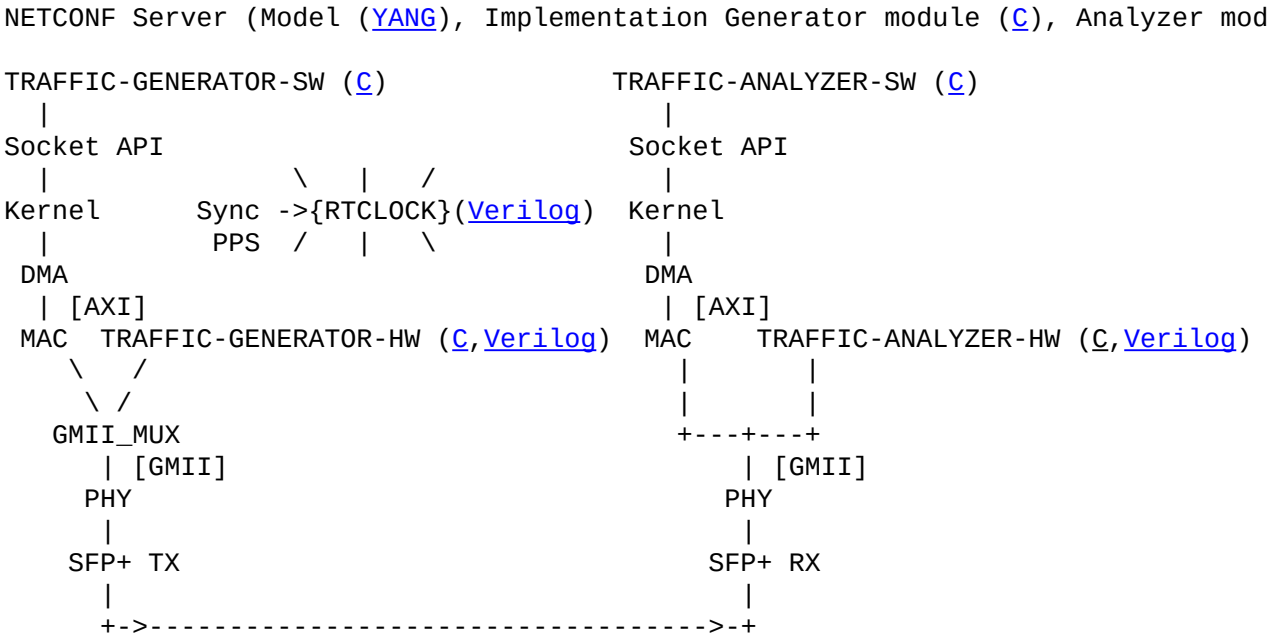
YANG tree diagram of the models

The following slide contains the complete YANG tree diagram of the ietf-traffic-generator.yang and ietf-traffic-analyzer.yang modules

```
module: ietf-traffic-analyzer
  augment /if:interfaces/if:interface:
    +--rw traffic-analyzer!
       +--rw testframe-filter! {testframe-filter}?
       |  +--rw type    identityref
       |  +--rw mask?   string
       |  +--rw data?   string
       +--rw capture {capture}?
       |  +--rw start-trigger
       |  |  +--rw (start-trigger)?
       |  |     +--:(frame-index)
       |  |     |  +--rw frame-index?       uint64
       |  |     +--:(testframe-index)
       |  |        +--rw testframe-index?   uint64
       |  +--rw stop-trigger
       |     +--rw (stop-trigger)?
       |        +--:(when-full)
       |           +--rw when-full?   empty
       +--ro state
          +--ro pkts?              yang:counter64
          +--ro octets?            yang:counter64
          +--ro idle-octets?       yang:counter64 {idle-octets-counter}?
          +--ro errors?            yang:counter64
          +--ro testframe-stats
          |  +--ro testframe-pkts?    yang:counter64
          |  +--ro sequence-errors?   yang:counter64
          |  +--ro payload-errors?    yang:counter64
          |  +--ro latency
          |     +--ro samples?   uint64
          |     +--ro min?       uint64
          |     +--ro max?       uint64
          |     +--ro average?   uint64
          |     +--ro latest?    uint64
          +--ro capture {capture}?
             +--ro frame* [sequence-number]
                +--ro sequence-number    uint64
                +--ro timestamp?         yang:date-and-time
                +--ro length?            uint32
                +--ro data?              string
```

```
module: ietf-traffic-generator
  augment /if:interfaces/if:interface:
    +--rw traffic-generator
       +--rw (type)?
       |  +--:(single-stream)
       |  |  +--rw testframe-type?     identityref
       |  |  +--rw frame-size          uint32
       |  |  +--rw frame-data?         string
       |  |  +--rw interframe-gap      uint32
       |  |  +--rw interburst-gap?     uint32
       |  |  +--rw frames-per-burst?   uint32
       |  |  +--rw modifiers
       |  |     +--rw modifier* [id]
       |  |        +--rw id              uint32
       |  |        +--rw action          identityref
       |  |        +--rw offset          uint32
       |  |        +--rw mask            string
       |  |        +--rw repetitions     uint32
       |  +--:(multi-stream)
       |     +--rw streams
       |        +--rw stream* [id]
       |           +--rw id                     uint32
       |           +--rw testframe-type?        identityref
       |           +--rw frame-size             uint32
       |           +--rw frame-data?            string
       |           +--rw interframe-gap         uint32
       |           +--rw interburst-gap?        uint32
       |           +--rw frames-per-burst?      uint32
       |           +--rw frames-per-stream      uint32
       |           +--rw interstream-gap        uint32
       |           +--rw modifiers
       |              +--rw modifier* [id]
       |                 +--rw id               uint32
       |                 +--rw action           identityref
       |                 +--rw offset           uint32
       |                 +--rw mask             string
       |                 +--rw repetitions      uint32
       +--rw realtime-epoch?
       |        yang:date-and-time {realtime-epoch}?
       +--rw total-frames?
```

Design and implementation



* - underlined text has links to repositories

Some management transaction examples follow:

1. Configuration of 64 octet packet stream with dynamic timestamps with minial interframe gap on a traffic generator

2. Configuration of testframe filter with bitfield matching

3. Get counters and status information from the traffic anazlizer

* Notice the use of automated command line serialization with **yangcli**

1. Configure traffic generation:

```
yangcli user@192.168.4.145> create /interfaces/interface[name='eth0']/traffic-generator -- frame-size=64 interframe-gap=20 \
testframe-type=dynamic \
frame-data=123456789ABCDEF012345678080045000002E000000000A112CBCC0000201C0000202C0200007001A00000\
00102030405060708090A0B0C0D0E0F10119CD50E0F

<edit-config xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <target>
    <candidate/>
  </target>
  <default-operation>merge</default-operation>
  <test-option>set</test-option>
  <config>
    <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
      <interface>
        <name>eth0</name>
        <traffic-generator
          xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
          nc:operation="create"
          xmlns="urn:ietf:params:xml:ns:yang:ietf-traffic-generator">
          <testframe-type
            xmlns:nttg="urn:ietf:params:xml:ns:yang:ietf-traffic-generator">nttg:dynamic</testframe-type>
          <frame-size>64</frame-size>
          <frame-data>123456789ABCDEF012345678080045000002E000000000A112CBCC0000201C
0000202C0200007001A00000001020304050607080 90A0B0C0D0E0F10119CD50E0F</frame-data>
          <interframe-gap>20</interframe-gap>
        </traffic-generator>
      </interface>
    </interfaces>
  </config>
</edit-config>
```

2. Configure test frame filter:

```
yangcli user@192.168.4.145> create /interfaces/interface[name='eth1']/traffic-analyzer/testframe-filter
 -- type=bit-field-match data="123456789ABCDEF012345678" mask="000000000000FFFFFFFFFFFF"

<edit-config xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <target>
    <candidate/>
  </target>
  <default-operation>merge</default-operation>
  <test-option>set</test-option>
  <config>
    <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
      <interface>
        <name>eth1</name>
        <traffic-analyzer xmlns="urn:ietf:params:xml:ns:yang:ietf-traffic-analyzer">
          <testframe-filter
            xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
            nc:operation="create">
            <type
              xmlns:ntta="urn:ietf:params:xml:ns:yang:ietf-traffic-analyzer">ntta:bit-field-match</type>
            <mask>000000000000FFFFFFFFFFFF</mask>
            <data>123456789ABCDEF012345678</data>
          </testframe-filter>
        </traffic-analyzer>
      </interface>
    </interfaces>
  </config>
</edit-config>
```

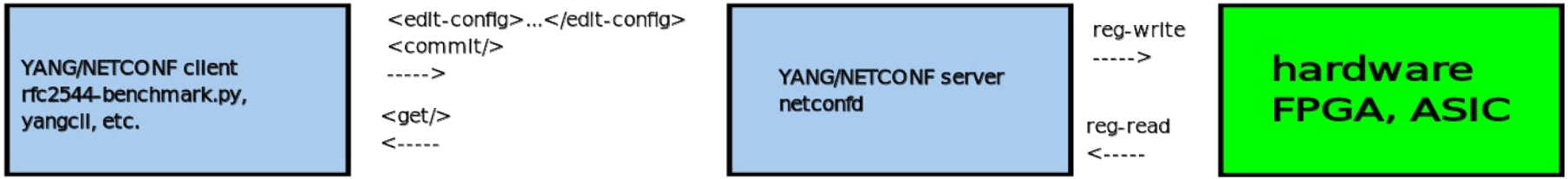
3. Get status information:

```
yangcli user@192.168.4.145>
xget /interfaces/interface/traffic-analyzer/state

<get
xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <filter type="xpath"
    select="/interfaces/interface/traffic-
analyzer/state"/>
</get>
```

```
<rpc-reply xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <data>
    <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
      <interface>
        <name>eth1</name>
        <traffic-analyzer xmlns="urn:ietf:params:xml:ns:yang:ietf-traffic-analyzer">
          <state>
            <pkts>43200851</pkts>
            <octets>2764854464</octets>
            <octets-idle>562950384</octets-idle>
            <bad-crc-octets>0</bad-crc-octets>
            <bad-crc-pkts>0</bad-crc-pkts>
            <bad-preamble-octets>0</bad-preamble-octets>
            <bad-preamble-pkts>0</bad-preamble-pkts>
            <octets-total>3630210805</octets-total>
            <testframe-stats>
              <pkts>43200851</pkts>
              <sequence-errors>0</sequence-errors>
              <latency>
                <samples>43200851</samples>
                <min-sec>0</min-sec>
                <min>832</min>
                <max-sec>0</max-sec>
                <max>864</max>
                <last-sec>0</last-sec>
                <last>864</last>
              </latency>
            </testframe-stats>
            <capture>
              <timestamp>
                <nsec>902536272</nsec>
              </timestamp>
              <sequence-number>43200851</sequence-number>
              <data>555555555555D5123456789ABCDEF012345678080045000002E000000000A112CBCC0000201
C0000202C0200007001A0000000000000293315200000000005E735CB98F0345964C7</data>
            </capture>
          </state>
        </traffic-analyzer>
      </interface>
    </interfaces>
  </data>
</rpc-reply>
```

Model defined pre-silicon testing environment



Alternatives:
* UVM, UVVM
*
Cadence/Spirent

...
sim-run 1000
ns
sim-finish

Pre-silicon testing

In the following example a RFC2544 benchmark against a **netconfd** server implementing the model by controling a gate-level simulation of the synthesizble traffic-generator-gmii and traffic-analyzer-gmii cores in **cocotb**
sim_time_ns=1565330 (we used bogus 10 Kb Ethernet speed to actually simulate the dataplane in realtime).

We published the results in a branch :

* Waveform trace (cocotb/iverilog gate-level generated)
* Report (with verbose NETCONF transaction)

Some random screenshots taken during this process complete this presentation.

Activities Terminal mars 20 15:53:56 en

vladimir@xps: ~/lsi/code/network-interconnect-tester-cores-...

```
pps=              0, pps=0, pps2=0
tic : time=               104000, sec=              0, nsec=       72, sec_next_
pps=              0, pps=0, pps2=0
   110.00ns INFO     cocotb.tester_loop.S_AXI           Write complete addr: 0x0
000000c prot: AxiProt.NONSECURE resp: AxiResp.OKAY length: 4
   110.00ns INFO     cocotb.tester_loop.S_AXI           Read start addr: 0x00000
00c prot: AxiProt.NONSECURE length: 4
tic : time=               112000, sec=              0, nsec=       80, sec_next_
pps=              0, pps=0, pps2=0
driving bus ...
tic : time=               120000, sec=              0, nsec=       88, sec_next_
pps=              0, pps=0, pps2=0
tic : time=               128000, sec=              0, nsec=       96, sec_next_
pps=              0, pps=0, pps2=0
tic : time=               136000, sec=              0, nsec=      104, sec_next_
pps=              0, pps=0, pps2=0
tic : time=               144000, sec=              0, nsec=      112, sec_next_
pps=              0, pps=0, pps2=0
   150.00ns INFO     cocotb.tester_loop.S_AXI           Read complete addr: 0x00
00000c prot: AxiProt.NONSECURE resp: AxiResp.OKAY data: ed cb a9 87
OK. Current value at REG_FLIP_ADDR is 0xEDCBA987 as expected
Listening ...
Accepting ...
```

vladimir@xps: ~

```
edit-transaction 82703: operation replace on session 1 by y123@127.0.0.1
  at 2024-03-20T14:47:09Z on target 'running'
  data: /if:interfaces/if:interface[if:name='eth1']
traffic_analyzer_io_dictdelete:

  ntta:traffic-analyzer {
  }
ses: session 1 shut by remote peer
Session 1 closed
ses: session 2 shut by remote peer
Session 2 closed^C
Shutting down the netconfd server

vladimir@xps:~$ netconfd --superuser=y123 --module=ietf-traffic-generator --modu
le=ietf-traffic-analyzer --no-startup
Starting netconfd...
Copyright (c) 2008-2012, Andy Bierman, All Rights Reserved.
Copyright (c) 2013-2022, Vladimir Vassilev, All Rights Reserved.

agt: Startup configuration skipped due to no-startup CLI option

Running netconfd server (2.14-0)
```

vladimir@xps: ~/lsi/code/network-interconnect-tester-cores-...

```
vladimir@xps:~/lsi/code/network-interconnect-tester-cores-git/systems/simulation
$ ./rfc2544-benchmark/rfc2544-benchmark --config=config.xml --dst-node=tester0 -
-dst-node-interface=eth1 --src-node=tester0 --src-node-interface=eth0 --dst-mac-
address="70:B3:D5:EC:20:10" --src-mac-address="70:B3:D5:EC:20:11" --dst-ipv4-add
ress="192.168.1.145" --src-ipv4-udp-port=49184 --src-ipv4-address="192.168.0.145
" --frame-size=64 --trial-time=2 --speed=10000 | tee rfc2544-benchmark-report-ve
rbose.txt | grep ^# | tee rfc2544-benchmark-report.txt
```

Device side:

* Software - YANG/NETCONF s
* Firmware - (Verilog)
* Hardware – off-the-shelf FPG
kit shield (KiCAD, Walk-throug
* Pre-silicon gate level simulat
hardware

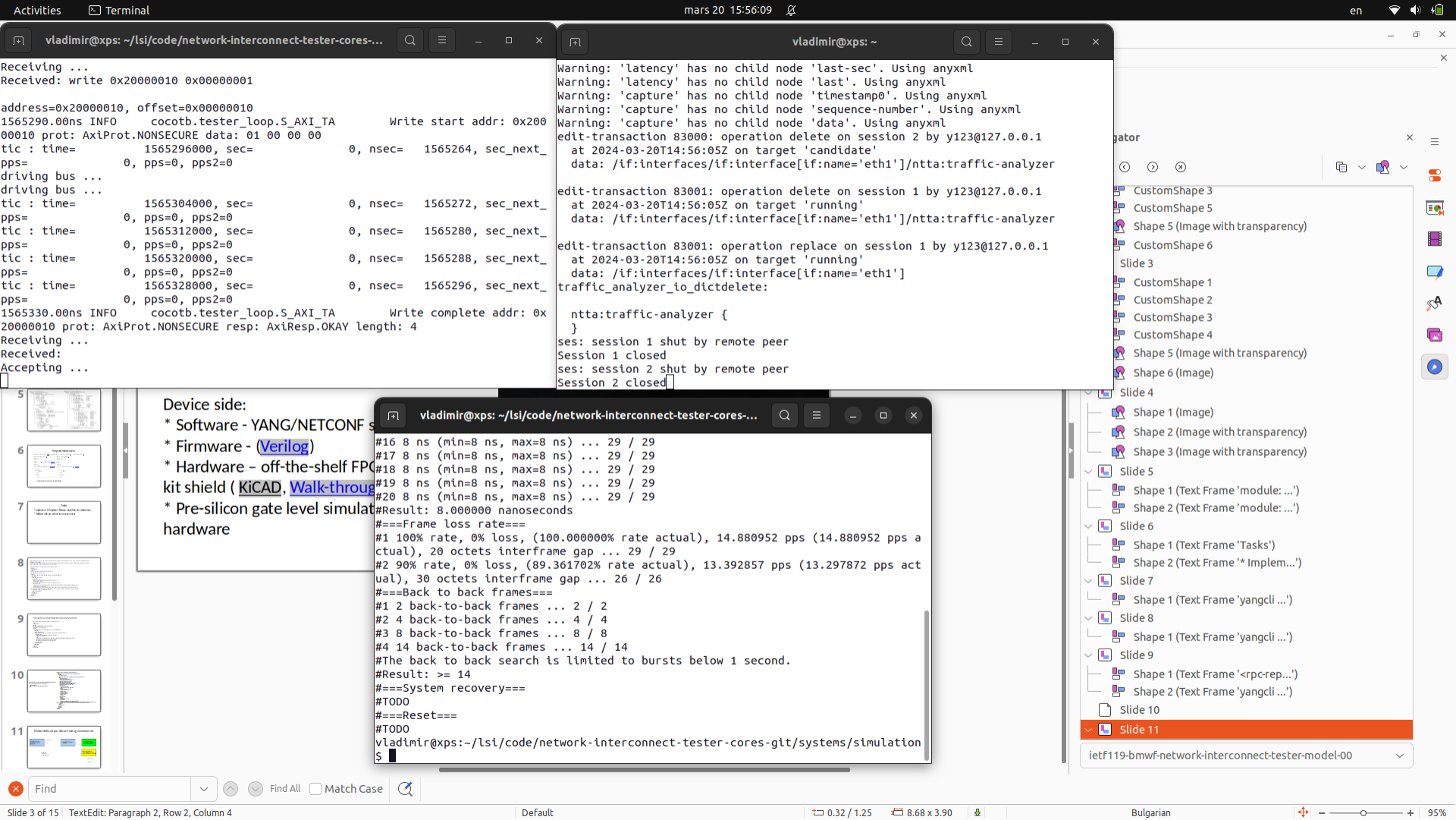
gator

- CustomShape 3
- CustomShape 5
- Shape 5 (Image with transparency)
- CustomShape 6
- Slide 3
- CustomShape 1
- CustomShape 2
- CustomShape 3
- CustomShape 4
- Shape 5 (Image with transparency)
- Shape 6 (Image)
- Slide 4
  - Shape 1 (Image)
  - Shape 2 (Image with transparency)
  - Shape 3 (Image with transparency)
- Slide 5
  - Shape 1 (Text Frame 'module: ...')
  - Shape 2 (Text Frame 'module: ...')
- Slide 6
  - Shape 1 (Text Frame 'Tasks')
  - Shape 2 (Text Frame '* Implem...')
- Slide 7
  - Shape 1 (Text Frame 'yangcli ...')
- Slide 8
  - Shape 1 (Text Frame 'yangcli ...')
- Slide 9
  - Shape 1 (Text Frame '<rpc-rep...')
  - Shape 2 (Text Frame 'yangcli ...')
- Slide 10
- Slide 11

ietf119-bmwf-network-interconnect-tester-model-00

Find Find All Match Case

Slide 3 of 15 TextEdit: Paragraph 2, Row 2, Column 4 Default 0.32 / 1.25 8.68 x 3.90 Bulgarian 95%


Activities
Terminal
mars 20 15:56:09
en
vladimir@xps: ~/lsi/code/network-interconnect-tester-cores-...
Receiving ...
Received: write 0x20000010 0x00000001
address=0x20000010, offset=0x00000010
1565290.00ns INFO cocotb.tester_loop.S_AXI_TA Write start addr: 0x200
00010 prot: AxiProt.NONSECURE data: 01 00 00 00
tic : time= 1565296000, sec= 0, nsec= 1565264, sec_next_
pps= 0, pps=0, pps2=0
driving bus ...
driving bus ...
tic : time= 1565304000, sec= 0, nsec= 1565272, sec_next_
pps= 0, pps=0, pps2=0
tic : time= 1565312000, sec= 0, nsec= 1565280, sec_next_
pps= 0, pps=0, pps2=0
tic : time= 1565320000, sec= 0, nsec= 1565288, sec_next_
pps= 0, pps=0, pps2=0
tic : time= 1565328000, sec= 0, nsec= 1565296, sec_next_
pps= 0, pps=0, pps2=0
1565330.00ns INFO cocotb.tester_loop.S_AXI_TA Write complete addr: 0x
20000010 prot: AxiProt.NONSECURE resp: AxiResp.OKAY length: 4
Receiving ...
Received:
Accepting ...
vladimir@xps: ~
Warning: 'latency' has no child node 'last-sec'. Using anyxml
Warning: 'latency' has no child node 'last'. Using anyxml
Warning: 'capture' has no child node 'timestamp0'. Using anyxml
Warning: 'capture' has no child node 'sequence-number'. Using anyxml
Warning: 'capture' has no child node 'data'. Using anyxml
edit-transaction 83000: operation delete on session 2 by y123@127.0.0.1
at 2024-03-20T14:56:05Z on target 'candidate'
data: /if:interfaces/if:interface[if:name='eth1']/ntta:traffic-analyzer
edit-transaction 83001: operation delete on session 1 by y123@127.0.0.1
at 2024-03-20T14:56:05Z on target 'running'
data: /if:interfaces/if:interface[if:name='eth1']/ntta:traffic-analyzer
edit-transaction 83001: operation replace on session 1 by y123@127.0.0.1
at 2024-03-20T14:56:05Z on target 'running'
data: /if:interfaces/if:interface[if:name='eth1']
traffic_analyzer_io_dictdelete:
ntta:traffic-analyzer {
}
ses: session 1 shut by remote peer
Session 1 closed
ses: session 2 shut by remote peer
Session 2 closed
Device side:
* Software - YANG/NETCONF
* Firmware - (Verilog)
* Hardware – off-the-shelf FP
kit shield (KiCAD, Walk-throug
* Pre-silicon gate level simulat
hardware
vladimir@xps: ~/lsi/code/network-interconnect-tester-cores-...
#16 8 ns (min=8 ns, max=8 ns) ... 29 / 29
#17 8 ns (min=8 ns, max=8 ns) ... 29 / 29
#18 8 ns (min=8 ns, max=8 ns) ... 29 / 29
#19 8 ns (min=8 ns, max=8 ns) ... 29 / 29
#20 8 ns (min=8 ns, max=8 ns) ... 29 / 29
#Result: 8.000000 nanoseconds
#===Frame loss rate===
#1 100% rate, 0% loss, (100.000000% rate actual), 14.880952 pps (14.880952 pps actual), 20 octets interframe gap ... 29 / 29
#2 90% rate, 0% loss, (89.361702% rate actual), 13.392857 pps (13.297872 pps actual), 30 octets interframe gap ... 26 / 26
#===Back to back frames===
#1 2 back-to-back frames ... 2 / 2
#2 4 back-to-back frames ... 4 / 4
#3 8 back-to-back frames ... 8 / 8
#4 14 back-to-back frames ... 14 / 14
#The back to back search is limited to bursts below 1 second.
#Result: >= 14
#===System recovery===
#TODO
#===Reset===
#TODO
vladimir@xps:~/lsi/code/network-interconnect-tester-cores-git/systems/simulation
$
CustomShape 3
CustomShape 5
Shape 5 (Image with transparency)
CustomShape 6
Slide 3
CustomShape 1
CustomShape 2
CustomShape 3
CustomShape 4
Shape 5 (Image with transparency)
Shape 6 (Image)
Slide 4
Shape 1 (Image)
Shape 2 (Image with transparency)
Shape 3 (Image with transparency)
Slide 5
Shape 1 (Text Frame 'module: ...')
Shape 2 (Text Frame 'module: ...')
Slide 6
Shape 1 (Text Frame 'Tasks')
Shape 2 (Text Frame '* Implem...')
Slide 7
Shape 1 (Text Frame 'yangcli ...')
Slide 8
Shape 1 (Text Frame 'yangcli ...')
Slide 9
Shape 1 (Text Frame '<rpc-rep...')
Shape 2 (Text Frame 'yangcli ...')
Slide 10
Slide 11
ietf119-bmwf-network-interconnect-tester-model-00
Find
Find All
Match Case
Slide 3 of 15
TextEdit: Paragraph 2, Row 2, Column 4
Default
0.32 / 1.25
8.68 x 3.90
Bulgarian
95%

GTKWave - sim_build/tester_loop.fst

File Edit Search Time Markers View Help

From: 0 sec To: 156533000 Marker: 34232 ns | Cursor: 123800 ns

SST

- tester_loop
  - rtclock0 (rtclock)
  - traffic_analyzer_gmii0 (t
    - bram_io_inst (bram_i
    - ethernet_crc_8_check
    - opl_cpu_regs_inst (tr
    - testframe_parser_0 (
  - traffic_generator_gmii0
    - bram_io_inst (bram_i
    - ethernet_crc_8_0 (eth
    - opl_cpu_regs_inst (tr

Type	Signals
wire	preamble_ok
wire	resetn
reg	run
wire	sec[47:0]
reg	sequence_errors[63:0]
integer	sequence_errors_delta
reg	sequence_errors_reg[
wire	sequence_num[63:0]
reg	state[1:0]
wire	testframe_filter_data[
wire	testframe_filter_mask
wire	testframe_match
reg	testframe_pkts[63:0]
integer	testframe_pkts_delta
reg	testframe_pkts_reg[6
reg	timestamp_nsec[31:0]
reg	timestamp_nsec_reg[3
reg	timestamp_sec[63:0]
reg	timestamp_sec_reg[6
wire	timestamp_tx_nsec[31
wire	timestamp_tx_sec[47:

Filter:

Append Insert Replace

Signals

Time
S_AXI_ACLK
S_AXI_AWADDR[31:0]
S_AXI_WDATA[31:0]
clk
control_reg[31:0]
gmii_d[7:0]
gmii_en
resetn
nsec[29:0]
testframe_match
sequence_num[63:0]
pkts_reg[63:0]
octets_reg[63:0]
testframe_pkts[63:0]

Waves

100 us 200 us 300 us 400 us

xxxxxxxx 10000010
xxxxxxxx 00000003 00000000
00000000 00000003 00000000
00 00
0000000000000000 0000000000000000 0000000000000000 0000000000000000 0000000000000000 0000000000000000 0000000000000000
0000000000000000 000000000000001D 000000000000003A 0000000000000057 0000000000000074 0000000000000091 00000000000000AE
0000000000000000 0000000000000740 0000000000000E80 0000000000001C0 0000000000001D00 0000000000002440 0000000000002B80
0000000000000000 000000000000001D 000000000000003A 0000000000000057 0000000000000074 0000000000000091 00000000000000AE

GTKWave - sim_build/tester_loop.fst

File Edit Search Time Markers View Help

From: 0 sec To: 156533000 Marker: 34254 ns | Cursor: 32797 ns

SST

- tester_loop
  - rtclock0 (rtclock)
  - traffic_analyzer_gmii0 (t
    - bram_io_inst (bram_i
    - ethernet_crc_8_check
    - opl_cpu_regs_inst (tr
    - testframe_parser_0 (
  - traffic_generator_gmii0
    - bram_io_inst (bram_i
    - ethernet_crc_8_0 (eth
    - opl_cpu_regs_inst (tr

Type	Signals
wire	preamble_ok
wire	resetn
reg	run
wire	sec[47:0]
reg	sequence_errors[63:0]
integer	sequence_errors_delta
reg	sequence_errors_reg[
wire	sequence_num[63:0]
reg	state[1:0]
wire	testframe_filter_data[
wire	testframe_filter_mask
wire	testframe_match
reg	testframe_pkts[63:0]
integer	testframe_pkts_delta
reg	testframe_pkts_reg[6
reg	timestamp_nsec[31:0]
reg	timestamp_nsec_reg[
reg	timestamp_sec[63:0]
reg	timestamp_sec_reg[6
wire	timestamp_tx_nsec[31
wire	timestamp_tx_sec[47:

Filter:

Append Insert Replace

Signals

Time
S_AXI_ACLK
S_AXI_AWADDR[31:0]
S_AXI_WDATA[31:0]
clk
control_reg[31:0]
gmii_d[7:0]
gmii_en
resetn
nsec[29:0]
testframe_match
sequence_num[63:0]
pkts_reg[63:0]
octets_reg[63:0]
testframe_pkts[63:0]

Waves

GTKWave - sim_build/tester_loop.fst

File Edit Search Time Markers View Help

From: 0 sec To: 156533000 Marker: 34254 ns | Cursor: 34159 ns

SST

- tester_loop
  - rtclock0 (rtclock)
  - traffic_analyzer_gmii0 (t
    - bram_io_inst (bram_i
    - ethernet_crc_8_check
    - opl_cpu_regs_inst (tr
    - testframe_parser_0 (
  - traffic_generator_gmii0
    - bram_io_inst (bram_i
    - ethernet_crc_8_0 (eth
    - opl_cpu_regs_inst (tr

Type	Signals
wire	preamble_ok
wire	resetn
reg	run
wire	sec[47:0]
reg	sequence_errors[63:0]
integer	sequence_errors_delta
reg	sequence_errors_reg[
wire	sequence_num[63:0]
reg	state[1:0]
wire	testframe_filter_data[
wire	testframe_filter_mask
wire	testframe_match
reg	testframe_pkts[63:0]
integer	testframe_pkts_delta
reg	testframe_pkts_reg[6
reg	timestamp_nsec[31:0]
reg	timestamp_nsec_reg[3
reg	timestamp_sec[63:0]
reg	timestamp_sec_reg[6
wire	timestamp_tx_nsec[31
wire	timestamp_tx_sec[47:

Filter:

Append Insert Replace

Signals

Time
S_AXI_ACLK
S_AXI_AWADDR[31:0]
S_AXI_WDATA[31:0]
clk
control_reg[31:0]
gmii_d[7:0]
gmii_en
resetn
nsec[29:0]
testframe_match
sequence_num[63:0]
pkts_reg[63:0]
octets_reg[63:0]
testframe_pkts[63:0]

Waves

34200 ns 34300 ns

10000024 10000010

0000001D 00000003

00000000 00000003

00 55 D5 70 B3 D5 EC 20 10 70

000+ 000085+ 000086+

0000000000000000

The End